Preaccession Fitness and Body Composition as Predictors of Attrition in U.S. Army Recruits

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ABSTRACT The Assessment of Recruit Motivation and Strength (ARMS) project evaluated whether active duty Army enlistees who exceeded weight and body-fat standards but were able to pass the ARMS physical fitness test were at elevated risk of early attrition relative to the traditional recruit population. Attrition among 1,146 overweight and over-body-fat (OBF) recruits who passed ARMS was compared to 10,514 fully qualified (FQ) recruits who began service in February 2005 through September 2006. The ARMS test includes a 5-minute step test and a 1-minute pushup test. There were no significant differences in attrition between OBF and FQ at 180 days: adjusted hazard ratios were 1.17 (95% CI: 0.83, 1.65) among females and 1.23 (95% CI: 0.95, 1.58) among males. This study indicates that physically fit recruits who exceeded weight/body-fat standards were equally capable of serving at least 180 days compared to those who met standards.

INTRODUCTION

The epidemic of overweight and obesity is well known in the United States population. According to the data from the 2003–2004 National Health and Nutrition Examination Survey (NHANES), the prevalence of overweight and obese adults was 66% (ages 20 and over), approximately 32% of whom were classified as obese.[1] Increasing prevalence of overweight is also reflected in the U.S. military applicant pool. In a recent study of civilian adults ages 17 to 42 years (the eligible age range for military enlistment), 18 to 54% of men and 21 to 55% of women, depending on age range and branch of service, exceeded the weight standards allowed for military enlistment.[2] The Army Medical Surveillance Activity reported that from 1993 to 2006, the prevalence of overweight among 18-year-old applicants to the military increased from 23% to 27%, and the prevalence of obesity increased from 3% to 7%.[3] A study of 1973, 1985, and 1998 recruits showed that the 1998 recruits tended to have more body weight and a greater percentage of body fat; however, aerobic capacity, muscle strength, and fat-free mass of 1998 recruits was comparable to or greater than that of 1978 and 1983 recruits.[4] This suggests that the increased body weight and fat among current recruits does not necessarily imply a lower overall fitness level.

The military currently applies a two-tiered screen as its weight and body-fat standard. Screening weights are the first level of assessment. If the applicant is within the allowable screening weight for his or her height and age group, then he or she is qualified. Otherwise, the individual's body-fat percentage is calculated by circumferential anatomic measurement and by gender-specific formulas.[5] For Army applicants, the maximum allowable accession body fat varies with age and gender, up to 30% for males and 36% for females 40 years of age and older.[6] This gender bias is based on the observation that although both men and women lose weight and body fat in basic training, men generally continue to lose weight through the first 6 months of service although women generally regain and add weight.[7]

Body mass index (BMI) and body-fat percentage measurements, typically poor indicators of general physical performance, have been used by the military because of the notion that ideal-weight service members appear and are more physically fit than overweight ones.[8] In 2006, the National Academies of Science Committee on Youth Population and Military Recruitment reported that weight and height standards are less predictive of attrition than aerobic fitness.[9] The committee also recommended that body mass index not be used as a proxy measure for fitness in the military population and recommended that prebasic training fitness be assessed as a viable and cost-effective route to reduce attrition. Although there is no fitness standard for enlistment in any of the U.S. military services, there is a precedent for screening in foreign military and several civilian occupations, such as firefighters and law enforcement.[10–12] A variety of fitness screening protocols have been used and studied in these physically strenuous occupations, including assessments of cardiovascular fitness, muscular strength, and body composition. Step testing can be an effective means of rapidly testing a large number of individuals in limited space with minimal expense for equipment and is a good indicator of aerobic fitness.[13,14]

The purpose of this study was to determine whether individuals who exceeded the traditional Army standards for weight and body fat, but were able to demonstrate physical fitness, were capable of serving in the Army. In particular, this study compared the rate of early attrition among the two

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The views expressed are those of the authors and should not be construed to represent the positions of the Department of the Army or Department of Defense.

This manuscript was received for review in August 2008. The revised manuscript was accepted for publication in March 2009.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Preaccession Fitness and Body Composition as Predictors of Attrition in U.S. Army Recruits	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Accession Medical Standards Analysis and Research Activity,Division of Preventive Medicine. Walter Reed Army Institute of Research,503 Robert Grant Ave,Silver Spring,MD,20910**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**8**	

groups of active duty Army enlistees: those that met the traditional weight-for-height or body-fat limits, and a study group that exceeded the allowable percentage of body fat (to a maximum level), but were deemed fit by their performance on the ARMS physical fitness assessment test.

METHODS

ARMS is a cohort study that began in 2004, the first phase of which focused on the fully qualified Army recruits. The ARMS study design and methods are reported in more detail elsewhere.[15] The study was approved by the Walter Reed Army Institute of Research Human Use Review Board.

STUDY SUBJECTS

Inclusion Criteria

All applicants for active duty Army enlisted service processed at any of six Military Entrance Processing Station (MEPS) locations (Atlanta, Buffalo, Chicago, Sacramento, San Antonio, and San Diego) during Feb 8, 2005–Sep 30, 2006 were required to take the ARMS test. Those who exceeded the Army accession standards for weight and body fat but were able to pass the ARMS test were given a provisional ARMS waiver to enter the service during the ensuing 30 days without having to meet the weight and body-fat standards. Those who met all Army accession standards were also required to take the ARMS test, but their performance on the test had no impact on their enlistment eligibility. All subjects were also required to take the Physical Activity Readiness Questionnaire (PAR-Q)[16] to assess the capability and readiness of applicants for ARMS testing. Only those applicants who were 18 years of age or older at the time of ARMS testing and who provided written informed consent to allow follow-up and outcome analysis were included in this study.

SUBJECTS WERE CATEGORIZED ACCORDING TO THEIR WEIGHT AND BODY-FAT STATUS

(1) Over Body Fat (OBF): those who exceeded the weight and body-fat standards but were able to join the service with an ARMS waiver (i.e., by passing ARMS), up to a maximum body fat of 30% for males and 36% for females based on the current standards for recruits age 40 years and above.
(2) Fully Qualified (FQ): those who did not exceed the weight for height and body-fat standards and took the ARMS test (regardless of performance on that test).

Exclusion Criteria

Air Force, Marine, and Navy active duty and Reserve recruits and Army Reserve recruits were excluded from this analysis. Anyone who answered "Yes" to question H on the PAR-Q (Do you have any concerns about doing moderate physical activity today?) was not eligible to participate in the ARMS testing. Recruits who did not meet the medical accession standards outlined in DoDI 6130.4[17] and did not receive a waiver for their medical condition, were not allowed to enlist regardless of body-fat status.

ARMS Test Components

The ARMS test comprises two components: the step test and the pushup test.

Step Test

Subjects performed a modified Harvard step test[18–20] by stepping up and down on a 21 × 27 inch, nonskid, adjustable platform set to a height of 12 inches for females and 16 inches for males. Stepping pace was kept by a metronome at 120 beats per minute, so that a subject should get both feet up on the platform and then back down 30 times per minute. Subjects performed the step test for 5 minutes or until failure to continue at the proper pace. The passing criterion for the step test was set at completing the full 5 minutes at the correct pace, with a 1-minute postexercise heart rate of less than 180 beats per minute.

Pushups

Upper body muscular endurance was tested by requiring recruits to complete as many pushups as possible in 1 minute. Males and females were required to complete a minimum of 15 and 4 pushups, respectively, to pass this portion of ARMS. The number of pushups was based on standards already being used by the Army to qualify new recruits to begin basic combat training as well as on performance data collected during phase one of the study.[21]

Primary Outcomes and Independent Variable

The endpoint for this analysis was premature attrition from military service, i.e., discharge from service within the first year. Attrition was examined at 90, 180, and 365 days. Ninety days was chosen as an approximation for 10-week basic training plus in-processing time, although 180 and 365 days were studied because the length of advanced training for occupational qualification is variable. The OBF status was the main independent variable analyzed in relation to attrition.

Assessment of Covariates

Established risk factors for early attrition were recorded at the time of ARMS testing or at the time of accession, including gender, age (18–20, 21–25, 26–30, >30), race (Black, White, or other), ethnicity (Hispanic or non-Hispanic), current use of tobacco products (no or yes: cigarettes, cigars, or smokeless tobacco), and BMI. BMI was categorized as underweight (<18.5), normal (18.5–24.9), overweight (25–29.9), and obese (>30).[22] BMI was not included in the model because it was highly correlated with OBF status.

Data Sources

Data on the ARMS test performance were collected by the trained staff at the six MEPS according to the design of the

study. Enrollment data were collected from February 2005 to September 2006. Attrition data on study subjects through July 2007 were obtained from the Center for Accession Research, U.S. Army Recruiting Command (USAREC), Fort Knox, KY. These data included information regarding military accession and discharge dates and reasons for discharge, where applicable.

Statistical Analysis

Study sample size allowed a 95% probability of detecting a 20% difference in attrition between OBF and FQ among active duty Army applicants. All analyses were performed using SAS (SAS Institute, Cary, NC; version 9.1).

Categorical statistical analysis methods were used to examine and compare the two study groups on demographic distributions and other factors potentially related to attrition. The homogeneity of the distribution among categorical variables was examined by χ^2 test and the mean of the continuous variables was examined by standard normal test. Missing data were excluded from all models with the exception of ethnicity, whereby including or excluding the missing values had no significant effect on the estimates.

Kaplan-Meier (K-M) survival analysis was then used to examine the unadjusted attrition patterns between the OBF and FQ cohorts through the first year of service. Those individuals who were followed for less than 1 year and did not attrite were censored. Proportional hazards (PH) models were applied to assess the adjusted effect of being OBF after controlling for age, race, ethnicity, and tobacco use. Two of the age categories (26–30 and >30) were combined during modeling because of low cell counts. The analyses were performed by gender separately. The assumption underlying this modeling, particularly that the effect of a predictor factor on hazard remaining constant over time, was assessed by applying K-M estimation and time-dependent PH modeling. The models were restricted to time windows increasing by 3 months through 12 months of service, which allowed us to examine for linear and nonlinear time effects.[23] Attrition hazard ratios (HR) associated with being OBF and passing ARMS compared to FQ were then examined and compared. Statistical significance was defined as the probability of the observed difference between study groups of less than 0.05.

Attributable risk is calculated by subtracting attrition incidence in the unexposed (FQ) from the incidence in the exposed (OBF).[24] Attributable risk percentage (AR%) in this study is the percentage of attrition incidence attributable to being OBF; i.e., the proportion of attrition incidence that would be eliminated if subjects were not OBF. The proportional hazards model was used to estimate the adjusted AR% of attrition over time because of OBF status.

RESULTS

Between February 2005 and September 2006, a total of 11,660 study subjects completed the ARMS test of whom 9,685 (83%) were male and 1,975 (17%) were female (Fig. 1). There was a greater proportion of OBF among females (16%) than among males (9%).

The majority of study subjects were between 18 and 20 years of age (59.5%) and were white (71.2%) (Table I). The distribution by age, race, and ethnicity was consistent among the OBF and FQ groups. Approximately one-third of the subjects declined to report their ethnicity status. Among individuals reporting current use of tobacco products, about 96% were cigarette smokers. As expected, there were significantly more overweight and obese among the OBF than FQ. Approximately 88% of OBF males and 12% of OBF females were categorized as obese. Interestingly, among the FQ males, 47% were classified in the overweight and obese categories.

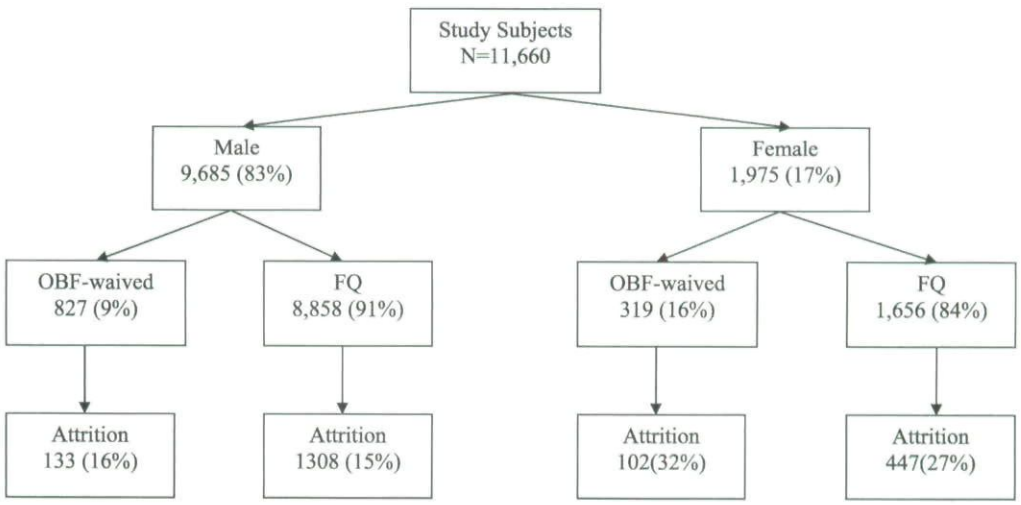

FIGURE 1. Study population summary, with unadjusted attrition (through July 2007) by gender and group: over body fat (OBF) versus fully qualified (FQ).

TABLE I. Characteristics of Study Subjects: by Gender and Study Group

Demographic Characteristic		Mean (SD) or Number (%)[d]			
		Male		Female	
		OBF $N = 827$	FQ $N = 8,858$	OBF $N = 319$	FQ $N = 1,656$
Age	18–20	502 (60.7)	5,200 (58.9)	202 (63.3)	1,010 (61.1)
	21–25	263 (31.8)	2,765 (31.3)	90 (28.2)	449 (27.2)
	26–30	51 (6.2)	635 (7.2)	21 (6.6)	132 (8.0)
	>30	11 (1.3)	226 (2.6)	6 (1.9)	61 (3.7)
Race[a*]	White	611 (73.9)	6,457 (73.2)	202 (63.3)	1,006 (60.8)
	Black	62 (7.5)	1,057 (12.0)	78 (24.5)	396 (24.0)
	Other	154 (18.6)	1,311 (14.8)	39 (12.2)	251 (15.2)
Ethnicity[b***]	Hispanic	154 (33.0)	1,841 (32.8)	62 (31.2)	404 (37.2)
	Non-Hispanic	312 (67.0)	3,778 (67.2)	136 (68.8)	682 (62.8)
Weight: mean (SD)		227.5 (26.9)	170.0 (34.2)	163.1 (18.0)	137.5 (23.4)
BMI[a**, b**]	Underweight	0	235 (2.7)	0	57 (3.5)
	Normal	2 (0.2)	4,423 (50.3)	17 (5.3)	1,061 (64.3)
	Overweight	98 (11.9)	2,862 (32.5)	263 (82.5)	491 (29.8)
	Obese	726 (87.9)	1,281 (14.5)	39 (12.2)	40 (2.4)
BMI: mean (SD)		32.9 (2.6)	25.2 (4.2)	27.8 (2.1)	23.6 (3.1)
Body-fat percentage[c]: mean (SD)		27.6 (2.0)	—	33.3 (2.1)	—
Current Tobacco use[a***]	Yes	188 (24.0)	2,300 (28.1)	48 (16.0)	317 (20.7)
	No	594 (76.0)	5,876 (71.9)	251 (84.0)	1,217 (79.3)

BMI, body mass index; FQ, fully qualified; OBF, over body fat; SD, standard deviation. $*p < 0.0001$; $**p < 0.001$; $***p < 0.05$. [a]Differences between FQ and OBF were tested with χ^2. [a]Significant for males. [b]Significant for females. [c]Body-fat percentage is only obtained in those who exceed weight standards (OBF). [d]Because of missing age, race, ethnicity, BMI, and tobacco use, the cells may not add to *N*.

The unadjusted relative risk of attrition for females was 1.18 (95% CI: 0.99, 1.42) and for males it was 1.09 (95% CI: 0.92, 1.28). Stratified attrition analysis by subgroups of percentage of body fat had no effect on the risk of attrition in OBF males or females (results not shown).

The unadjusted probability of retention is compared between OBF and FQ over the first year of service for females (Fig. 2) and males (Fig. 3). Among OBF and FQ subjects 8.9% and 12.3%, respectively, accessed in August and September of 2006 and did not have a potential for 12 months of service so they were censored if they did not attrite before July 2007. There were no significant differences between OBF and FQ among either males or females by any of the tests applied (p values from log rank, Wilcoxon, and log likelihood ratio were greater than 0.40).

The PH model of attrition within 180 days, adjusting for age, race, ethnicity, and history of smoking are presented by gender: females (Table II) and males (Table III). The 180-day period was selected because modeling by 30-day intervals indicated the proportionality assumption was not tenable past this time. Hazard ratios for OBF relative to FQ were not statistically significant for females (HR 1.17, 95% CI: 0.83–1.65, $p = 0.38$), nor for males (HR 1.23, 95% CI: 0.95–1.58, $p = 0.11$). Several factors demonstrated significant effects on attrition relative to their reference groups, including race (Black versus White) among both males (HR 0.71, $p = 0.01$) and females (HR 0.56, $p < 0.01$), and ethnicity (Hispanic versus non-Hispanic) among males, (HR 0.63, $p < 0.01$) as well as tobacco use (current use versus none) among females (HR 1.46, $p = 0.02$).

Attributable risk calculations indicated that the influence of being OBF on attrition decreased over time in service, with a more pronounced decrease among males than among females. Among females, the risk decreases from 13.0 (95% CI: −15.3, 41.3) at 180 days to 9.0 (−12.5, 30.4) at 365 days. Among males, the AR% decreases from 20.7 (1.4, 40.0) to 6.1 (−12.1, 24.2), respectively. Approximately a third of OBF male attrition and one-fifth of OBF female attrition in the first 90 days might be related to their exceeding weight and body-fat standards.

DISCUSSION

This study examined first-year attrition among 11,660 active duty Army enlistees who took the ARMS test at the time of application for service. Among these were 1,146 who were OBF at the time of application, but earned an accession waiver for this by passing the ARMS test. Unadjusted all-cause attrition rates during the first 365 days of service were not significantly different between OBF subjects and those who met the weight and body-fat standards. This was true for both the female subjects and the male subjects, without accounting for other known attrition risk factors.

The relationship between OBF status and the likelihood of attrition at 180 days was also found not significant when the effects of other known risk factors were included in the PH models. The effects of the other known attrition risk factors did not consistently achieve statistical significance, but their directionality was consistent with other studies.[25] Specifically,

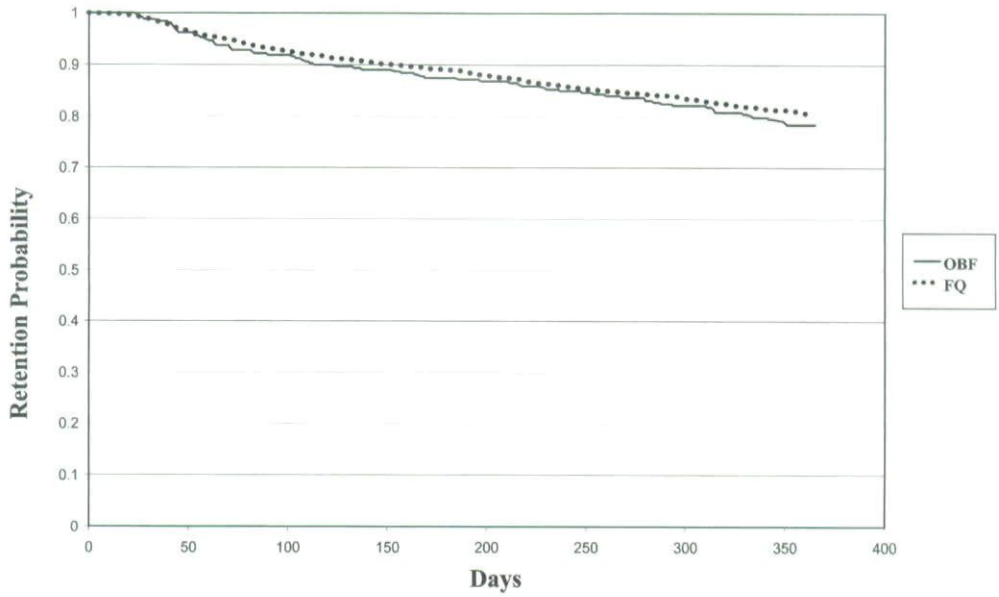

FIGURE 2. Retention probability during the first year of service among OBF and FQ subjects: females.

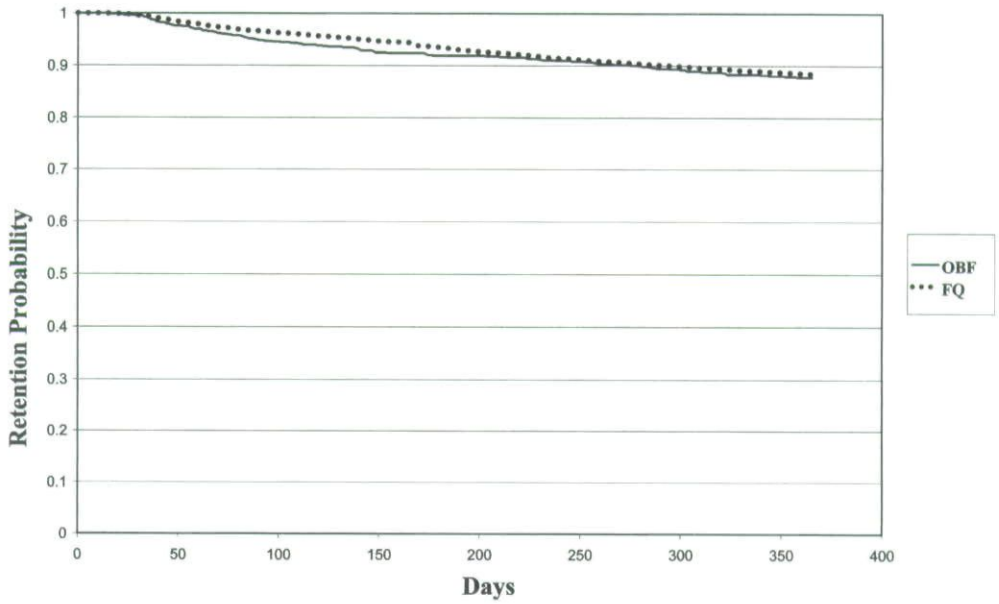

FIGURE 3. Retention probability during the first year of service among OBF and FQ subjects: males.

positive but not significant increases in attrition risk were associated with being older, White, non-Hispanic, and reporting a current use of tobacco products.

One limitation of this study is that assessing ARMS test performance involves some subjectivity with regard to whether proper pace was maintained on the step test. Although anecdotal information and observation suggested that subject preparation varied considerably across the study sites, the wide range of pass percentages by site (60.9%–97.4%) suggests that subjectivity might play a role. However, previous analysis of BMI and retention probabilities by gender with MEPS location as a control factor showed the MEPS effect was not significant.[25]

This is the first prospective study conducted in the U.S. Army of a waiver program for accession body-fat standards with demonstrated physical fitness, as measured by the ARMS test. Long-term follow-up of the OBF cohort, beyond 12 months of service when retention weight and body-fat standards apply, is ongoing as well as through study subjects' initial enlistment period of up to 5 years. A study is also being conducted of ARMS test performance as a predictor of morbidity outcomes (e.g., heat illnesses and musculoskeletal injuries), which have been found to be increased in those with poor fitness.[12,21,26]

Physical fitness and the motivation to serve, as measured by the ARMS test, have been shown to be protective against the known association between high BMI and attrition. The

TABLE II. Proportional Hazard Model of the Effects on Attrition Within 180 Days: Females

Factor	Values	Parameter Estimates	Standard Error	Hazard Ratio	95% CI	*p* value
Group	FQ (Reference Group)	0.00	—	1.00	—	—
	OBF	0.15	0.18	1.17	(0.83, 1.65)	0.38
Age	18–20 (Reference Group)	0.00	—	1.00	—	—
	21–25	0.07	0.16	1.07	(0.79, 1.46)	0.65
	>26	0.34	0.20	1.40	(0.94, 2.09)	0.10
Race	White (Reference Group)	0.00	—	1.00	—	—
	Black	−0.59	0.19	0.56	(0.38, 0.81)	0.00
	Other	0.00	0.19	1.00	(0.69, 1.45)	0.99
Ethnicity	Hispanic	−0.26	0.20	0.77	(0.52, 1.15)	0.20
	Missing	0.34	0.15	1.41	(1.05, 1.89)	0.02
	Non-Hispanic (Reference Group)	0.00	—	1.00	—	—
Tobacco use	Yes	0.38	0.16	1.46	(1.07, 1.98)	0.02
	No (Reference Group)	0.00	—	1.00	—	—

TABLE III. Proportional Hazard Model of the Effects on Attrition Within 180 Days: Males

Factor	Values	Parameter Estimates	Standard Error	Hazard Ratio	95% CI	*p* value
Group	FQ (Reference Group)	0.00	—	1.00	—	—
	OBF	0.21	0.13	1.23	(0.95, 1.58)	0.11
Age	18–20 (Reference Group)	0.00	—	1.00	—	—
	21–25	0.15	0.09	1.16	(0.98, 1.37)	0.09
	>26	0.17	0.13	1.19	(0.92, 1.54)	0.19
Race	White (Reference Group)	0.00	—	1.00	—	—
	Black	−0.34	0.14	0.71	(0.54, 0.93)	0.01
	Other	−0.14	0.12	0.87	(0.69, 1.10)	0.25
Ethnicity	Hispanic	−0.46	0.12	0.63	(0.50, 0.81)	0.00
	Missing	0.08	0.09	1.08	(0.91, 1.28)	0.38
	Non-Hispanic (Reference group)	0.00	—	1.00	—	—
Tobacco use	Yes	0.02	0.09	1.02	(0.86, 1.22)	0.83
	No (Reference Group)	0.00	—	1.00	—	—

proportion of this effect because of physical fitness compared to motivation cannot be quantified in this study, although analysis of both OBF and FQ ARMS test failure subjects revealed that the majority had a step test duration of less than 3 minutes with a relatively low postexercise compared to pre-exercise heart rate. This finding suggests to us that they were relatively less motivated than physically unfit.

The ARMS test offers the potential to reduce morbidity and attrition as a future accession standard in times of an abundant recruiting pool for the all-volunteer force. Alternatively, in times of a limited recruiting pool, demonstrated physical fitness may be studied as a waiver criterion for selected prevalent disqualifications, particularly for weight and body-fat standards. In light of the current epidemic of obesity and inactivity in U.S. young adults and increasing recruiting mission to meet the increasing Army force structure, evidence-based BMI and body-fat standards based on military relevant outcome studies and cost–benefit analyses should be developed. This research has potential application in other branches of the military as well as in preplacement examinations for other physically demanding occupations, such as law enforcement or firefighters.

ACKNOWLEDGMENTS

We would like to thank Ms. Janice Gary and Ms. Vielka Rivera, AMSARA, WRAIR for their administrative support.

This study was funded by the U.S. Army Accession Command, U.S. Military Entrance Processing Command, and U.S. Army National Guard Bureau.

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